Remarks

Claims 1-18 are in the application, of which claim 1 is in independent form and claims 15-18 are new. Support for new claims 15-18 can be found in paragraphs [0032] and [0033] of the originally filed application.

Claims 11 and 12 stand rejected under 35 U.S.C. § 112, second paragraph, for indefiniteness. Regarding claim 11, the Examiner states that originally filed claim 11 does not limit independent claim 1 because "it is unclear how any laser would not fall into one of the three categories (since excimer lasers are UV lasers)." (August 24, 2004 Office action, page 2). Applicants have amended claim 11 to recite "[t]he differential diameter hole drilling method of claim 1, in which the first and second laser outputs are generated by one of a UV laser and a CO_2 laser," to embrace "solid-state laser[s] and excimer lasers" as stated in paragraph [0040] of the application. Regarding claim 12, the Examiner states that "[t]he meaning of 'UV:YAG' is unclear since no such laser exists." (Office action, page 2). Applicants have amended claim 12 to recite "the UV laser is an Nd:YAG emitting a laser beam having a wavelength of 355 nm." Support for this amendment can be found in paragraph [0041] of the application.

Claims 1-6, 8, 9, 10, 11, and 13 stand rejected under 35 U.S.C. § 102(b) as being anticipated by International Publication No. WO 86/02301 to Zahaykevich. The Examiner states that Zahaykevich teaches "laser drilling a pilot hole into a multilayered electronic circuit board, followed by generating a second laser output having sufficient energy density over a second spatial spot size to remove target material within a second spot area defined by the second spatial size to create a through-hole of the desired size and shape." (Office action, page 2, citations omitted). Applicants respond to this rejection as follows.

Zahaykevich teaches through-hole formation by drilling a hole "with a single shot." (Page 43, lines 30-31). This method of through-hole formation is commonly referred to as the "punching" method. In contrast, amended claim 1 of the present application is directed to the trepanning, concentric circle processing, or spiral processing methods of through-hole formation. These methods of through-hole formation are referenced in paragraphs [0032] and [0033] of the present application. Applicants have amended claim 1 to recite "directing the first laser output to impinge the target material at a first starting point located within the first spot area and moving the first laser output along a path whose distance from the first starting point constantly changes, thereby forming a pilot hole having a pilot hole diameter that corresponds to the diameter of the first spot area and that is less than the predetermined diameter of the through-hole," and

"directing the second laser output to impinge the target material at a second starting point located within the second spot area and moving the second laser beam along a path whose distance from the first starting point constantly changes, thereby forming a through-hole."

The trepanning, concentric circle processing, and spiral processing methods of through-hole formation offer various advantages over the punching method of through-hole formation. First, the punching method of through-hole formation results in the creation of a "recast layer on [the] inside wall" of the resulting through-hole, as described by Zahaykevich at page 43, line 26 through page 44, line 3. Although formation of the pilot hole described in Zahaykevich may minimize the creation of a recast layer, the walls of the resulting through-hole will not have the degree of surface uniformity provided by the trepanning, concentric circle processing, and spiral processing methods of through-hole formation described in the present application. This is so because these methods of through-hole formation minimize creation of the recast layer, by moving the first and second laser outputs along a path whose distance from the first and second starting points constantly changes, as recited in amended claim 1.

Second, the punching method of through-hole formation creates a debris plume in the laser output axis of subsequent pulses. In contrast, the trepanning, concentric circle processing, and spiral processing methods of through-hole formation do not create this debris plume.

Third, the punching method of through-hole formation is less energy-efficient than the trepanning, concentric circle processing, and spiral processing methods because, when using the punching method, a significant amount of thermal energy must be devoted to ablating the recast layer and the debris plume. Thus, either more thermal energy must be used to form the through-hole or through-hole formation will take longer. In contrast, the trepanning, concentric circle processing, and spiral processing methods of through-hole formation minimize the formation of a recast layer or of a debris plume, so less energy must be devoted to ablating these undesirable effects of laser drilling.

Fourth, most applications of conventional punching require the beam positioning system to be completely stopped over the target area of the target material. Consequently, the target area to target area move time includes a beam position settling time. However, when using the trepanning, concentric circle processing, or spiral processing method of through-hole formation, the beam positioning system can be (and is preferably) in constant motion, thereby reducing or eliminating settling time between each target area to target area move.

Because Zahaykevich teaches only through-hole formation by punching, Zahaykevich does not teach through-hole formation by trepanning, concentric circle processing, or spiral processing, as expressed by the above-quoted operative claim language recited in paragraphs two and four of the body of amended claim 1. For this reason, Zahaykevich does not anticipate amended claim 1.

Claims 7 and 12 stand rejected under 35 U.S.C. § 103(a) for obviousness over Zahaykevich in view of U.S. Patent No. 6,433,301 to Dunsky et al. Claim 14 stands rejected under 35 U.S.C. § 103(a) for obviousness over Zahaykevich in view of European Patent No. 544,398 to Williams. Applicants choose to rely on the arguments presented above with respect to amended, independent claim 1 to support the patentability of its dependent claims.

With specific reference to dependent claims 3, 4, 5, and 11 (as amended), these claims stands rejected under 35 U.S.C. § 102(b) as being anticipated by International Publication No. WO 86/02301 to Zahaykevich. Applicants disagree with the Examiner's rejection of these claims.

With reference to dependent claim 3, applicants assert that Zahaykevich does not describe "forming a portion of the through-hole before forming the pilot hole, the portion of the through-hole having the predetermined diameter and extending only partly through the thickness of the target material," as recited in claim 3. Rather, Zahaykevich describes drilling a small pilot hole and reaming it to achieve a final diameter. (Page 44, lines 3-4). Zahaykevich never describes forming a portion of the through-hole having the predetermined diameter before forming the smaller-diameter pilot hole. Because Zahaykevich does not describe the recited claim language, Zahaykevich does not anticipate dependent claim 3.

With reference to dependent claim 4, applicants assert that Zahaykevich does not describe "the pilot hole and the through-hole hav[ing], respectively, a pilot hole axis and a through-hole axis, and in which the directing the second laser output to impinge the target material includes spatially aligning the through-hole and pilot hole axes," as recited in claim 4. Zahaykevich states that a small pilot hole is drilled, but does not state how the hole is drilled. As such, Zahaykevich does not describe co-axial alignment of the pilot hole and the through-hole, as described in claim 4. Because Zahaykevich does not describe the recited claim language, Zahaykevich does not anticipate dependent claim 4.

With referece to dependent claim 5, applicants assert that Zahaykevich does not describe a "pilot hole [that] extends only partly through the thickness of the target

material," as recited in claim 5. Instead, Zahaykevich describes "a small hole [is] drilled through the material" (page 48, lines 14-15; see also page 43, line 22). Zahaykevich teaches the formation of a pilot hole that extends through the thickness of the target material rather than the blind via-type pilot holes described in claim 5. Because Zahaykevich does not describe the recited claim language, Zahaykevich does not anticipate dependent claim 5.

With reference to amended dependent claim 11, applicants assert that Zahaykevich does not describe a drilling method "in which the first and second laser outputs are generated by one of a UV laser and a CO_2 laser," as recited in amended claim 11. Zahaykevich describes only the use of a ruby laser to effect a differential diameter hole drilling process. Further, at page 2, line 3 through page 5, line 9, Zahaykevich teaches away from the use of UV and CO_2 lasers in favor of a ruby laser. Because Zahaykevich does not describe the recited claim language, Zahaykevich does not anticipate dependent claim 11.

With specific reference to claim 12, which stands rejected under 35 U.S.C. § 103(a) for obviousness over Zahaykevich in view of U.S. Patent No. 6,433,301 to Dunsky et al., applicants disagree with the Examiner's rejection of this claim. Although the Examiner relies on Dunsky to teach formation of through-holes with an Nd:YAG laser, Zahaykevich, the primary reference, teaches away from the use of a an Nd:YAG laser at page 4, lines 6-25. Thus applicants do not believe that Zahaykevich in view of Dunsky anticipates dependent claim 12.

Applicants believe the application is in condition for allowance and respectfully request the same.

Respectfully submitted,

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